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V.—MAMMALIAN FOSSILS FROM DEVIL'S GULCH

BY ERWIN H. BARBOUR

The fauna of the beds at Devil's Gulch and vicinity is rich and varied, and promises to fill certain gaps in the Pliocene and early Pleistocene, where investigation seems especially desirable. The object of this paper is to make a partial faunal list and to describe two new proboscideans and a new equine.

ANCESTRAL PROBOSCIDEANS

The genealogy of this group is now so well known to naturalists, that it is interesting to note in the writings of Cope and others of twenty-five years ago, that the intermediate proboscideans are entirely lost, and the phylogeny of the order absolutely unknown. As a reward of zeal, the genetic gaps are being filled so rapidly, that ultimately knowledge of the history of the Proboscidea must be as well known as that of the Equidae. The affinities of the Proboscidea are with the Rodentia and Sirenia.

The oldest known progenitors of the Proboscidea are *Moeritherium* and *Palaeomastodon*. *Moeritherium* occurs in the Upper Eocene, and *Palaeomastodon* in the Lower Oligocene of Egypt, so Africa is accounted the birthplace of the group. After centuries of change their migrations took them throughout Africa, northward into Europe and the British Isles, into Euro-Asia, India, and Siberia, thence across the Siberian-Alaskan Isthmus of that time into North America, and by the Isthmus of Panama into South America. Thus they became world-wide in distribution.

During the ages required for these mutations and migrations, many degrees of specialization resulted.

THE SKULL

While the trunk and tusks were developing until they became ponderous, the superficial area of the skull was also increasing.

Otherwise there would not have been the extent of surface necessary for the attachment of muscles and ligaments to carry the ever-increasing load. This expanse of surface was brought about by the inflation of air cells in the cancellous tissue. This structure not only surrounds the brain, but extends into the maxillae, zygomatic arch, and other parts of the skull.

At first the proboscis was small, but little more than a prehensile lip, much like that of the horse, and used in much the same way, to guide food into the mouth. In the later mastodons, mammoths, and modern elephants, perfection of specialization was attained by this remarkable organ. This too added to the weight of the skull.

THE MANDIBLE

The lengthening and subsequent shortening of the mandibular tusks was paralleled by the lengthening and subsequent shortening of the mandible itself. The remotest known ancestor of the group had mandibles of a typical mammalian form, which in successors became increasingly atypical. As the mandibular tusks developed, mastodons became longirostral to the last degree. The symphysial prolongation, which was extreme in *Mastodon angustidens,* is reduced in the mammoths and present elephants to a mere process on the front of the jaw.

THE TEETH

The ancestral proboscidean had a number of teeth, after the manner of typical mammals, and these were erupted in the usual way, that is by new teeth pushing upward and gradually displacing the old. These are called teeth of vertical succession. But incident to progressive change, and extreme specialization, the teeth of mastodons and mammoths became too large for the jaw to accommodate many at a time, and finally the dentition was reduced, in fully matured adults, to one large specialized tooth in each jaw. These teeth were erupted in a singular manner, that is, by the one behind crowding forward, and pushing out the one in front. This is known as the horizontal succession of teeth. Ac-

PLATE I.

General View of Devil's Gulch. Looking up the canyon. Quarry No. 1 is at *a*.

PLATE II.

Nearing the Brink of the Canyon. Dragging out, by means of block and tackle, a slab containing the skull of *Tetrabelodon willistoni*. Quarry No. 2 is at *a*.

cordingly, the anterior cones and plates of mastodons and mammoths are ground in front long before they are worn behind.

The mandibular teeth of mastodons are ground most in front, and generally with an outward slant. This gives a clue to the orientation of odd mastodon teeth. The mandibular teeth of mammoths are roughly crescentic, the ground or worn surfaces are upward and forward, and the convexity inward, which enables one to orient and locate a given tooth. The maxillary teeth of mammoths are generally massive, the grinding surface is downward, and the greater convexity of surface outward.

Though the more advanced and specialized proboscideans have the number of grinding teeth reduced to one or two, they may have had, at some earlier stage in their life, four or five in use at once. This points to an ancestry with many grinders. The short-crowned (brachydont) teeth, with but three, four, or five transverse ridges, changed to the tall-crowned (hypsodont) teeth with ever-increasing transverse ridges found among the intermediate and true elephants. Increase in number of ridges signifies advancement. The earlier mastodons had 3 transverse ridges, later mastodons 4 or 5. The intermediate elephants, Stegodonts, had 6 to 12, and the mammoths and modern elephants 16 to 24, and even 28. Along with the multiplication of transverse ridges went the increase in cement reinforcement signifying specialization.

THE TUSKS

Morphologically, tusks are incisors which grow from persistent pulps. A series of fossil proboscideans show that the tusks gradually lengthened, and increased in weight, during the ages, until they became ponderous. Great muscles and sinews were necessary to support the weight of the ever-lengthening tusks and trunk. Accordingly, insensible changes took place. The early dolicocephalic skull, and longirostral jaw changed to the brachycephalic and brevirostral.

Early mastodons had short decurved tusks with enamel bands. Intermediate mastodons had longer and larger tusks with vestigial enamel bands, while later ones had long, straight, or slightly spiral tusks with the enamel band wanting. Though mastodon tusks are

generally slim and relatively straight, there are many examples with large dimensions and extreme curvature. The persistence of this vestigial enamel band even in modern elephants is significant. A foot or so may still be seen on young elephant tusks. This is soon worn off by use. Mammoths generally, though not invariably, have ponderous tusks distinctly curved and spiral. Those found in this State are noticeably spiral.

MASTODONS IN GENERAL

Cope's classification of the mastodons has for a long time made the strongest popular appeal. He divided them into *Tetrabelodon,* or the four-tuskers, and *Dibelodon,* or the two-tuskers. This simple division gives the public a clue to the primary divisions of the group. These terms are particularly appropriate and descriptive.

Mastodons may, in a similar manner, be classed according to the lobes of their teeth, as Trilophodonts (three-crested molars) and Tetralophodonts (four-crested molars). Though serving the purposes of the naturalist, this latter division is less obvious than the former. Both of these general classifications are very useful.

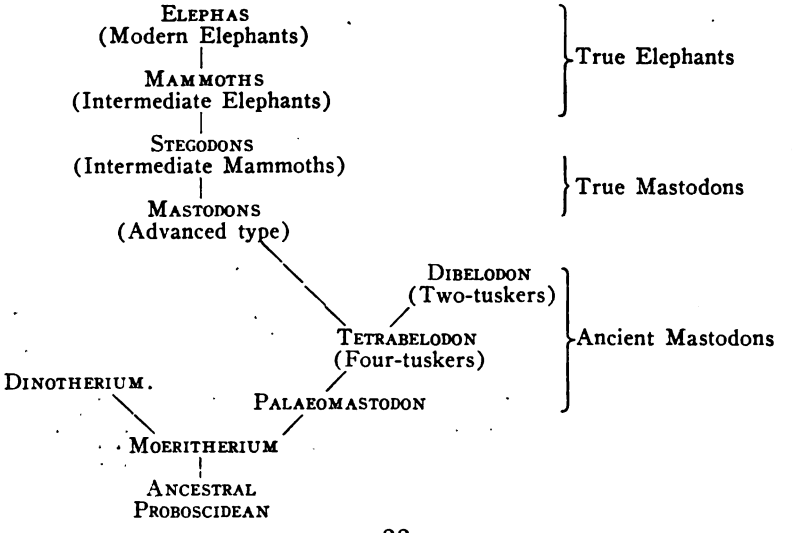
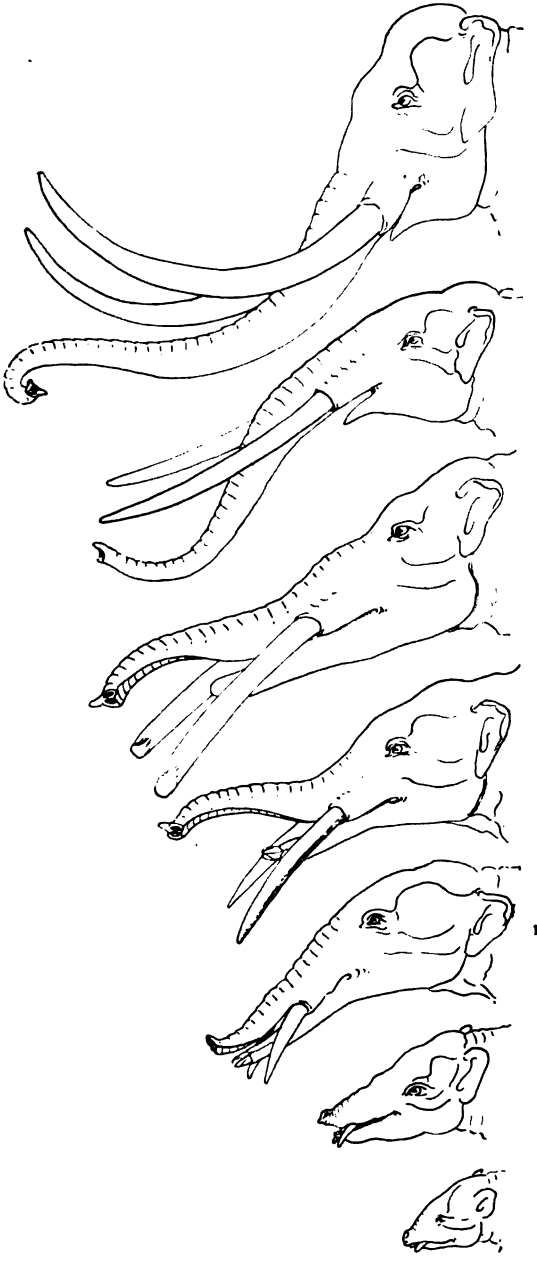


PLATE III.

Scene at Devil's Gulch. Dragging the pelvis of *Eubelodon morrilli* over the brink of the canyon by means of block and tackle.

PLATE IV.



7, Mammoth.
Pleistocene.
Three species, the Columbian, Imperial, and Primitive are abundant in Nebraska.

6, Mastodon.
Mastodon americanus.
Common in Nebraska.
Pleistocene.

5, *Eubelodon morrilli.*
A trilophodont mastodon
Pliocene.
Devil's Gulch, Nebraska.

4, *Tetrabelodon willistoni.*
A late four-tusker.
A trilophodont mastodon.
Pliocene of Nebraska.

3, *Tetrabelodon.*
An early four-tusked mastodon.
Miocene.

2, *Palaeomastodon.*
Lower Oligocene, Egypt.

1, *Moeritherium.*
Ancestral proboscidean.
Upper Eocene, Egypt.

PLATE I

Evolution of the Proboscidea. Freehand sketches, approximately to scale, from casts and specimens in the collection of Honorable Charles H. Morrill, State Museum.

The word mastodon has gone beyond the limits of scientific literature, and is now incorporated in our common speech. It seems to be the best and most expressive single word, and yet the name *Gomphotherium* (wedge-toothed beast) was proposed first, and has the right of priority. The reader will occasionally find *Mammut* in use by some writers, as *Mammut americanum,* which is synonymous with *Mastodon americanus.* Our word mammoth is an early English corruption for *Mammut.* The genus *Mastodon* must inevitably undergo many subdivisions, even though the multiplication of names is confounding to the general palaeontological reader.

MASTODONS AND MAMMOTHS IN NEBRASKA

Mastodons in Nebraska date from the late Miocene, continued through the Pliocene and Pleistocene and became extinct at the close of the glacial epoch. They ranged through the United States, Canada, Alaska, and Mexico. The present collections in the State Museum show at least seven distinct forms, namely: *Mastodon willistoni, M. morilli, M. euhypodon, M.* undetermined, *M.* undetermined, *M. mercificus, M. americanus.* It is believed that mastodons, though earlier arrivals, outlived the mammoths.

Three species of mammoths are well known in Nebraska, namely: *Elephas imperator, E. columbi,* and *E. primigenius.* The most majestic of them all, *Elephas imperator,* the giant imperial elephant, with a height exceeding 13 feet, ranged from Nebraska westward to the Pacific, and southward to Mexico, during Pleistocene times. The next largest, *Elephas columbi,* the great Columbian elephant, with a height of 10 to 11 feet, followed in the middle Pleistocene, and ranged over the entire United States and Mexico. These two mammoths had a southern adaptation. They were followed by a mammoth of a northern adaptation known as the great northern, or hairy mammoth, *Elephas primigenius,* which had a height of 9 feet. This is the mammoth best known to the public. Its range was west, extending from the Atlantic to the Pacific, along the northern part of the United States, throughout British Columbia, and over Alaska. Proboscideans attained ponderous size at a surprisingly early period, especially in Europe.

THE DEVIL'S GULCH BEDS

On a recent collecting trip to Devil's Gulch and vicinity, in northern Brown County, a large and varied collection representing the mammalian fauna of the Loup Fork beds of that region was secured for the University Museum. These fossils are a part of the extensive palaeontological collections of Honorable Charles H. Morrill, and may be counted the largest and most important, which have ever been secured for the University in so short a time. All of the material is highly interesting from the view point of the palaeontologist, and some of it is new and of first importance.

Early in May, 1913, Mr. A. C. Whitford, an assistant on the Nebraska State Geological Survey, and a Fellow in the Department of Geology, was sent to Devil's Gulch to prospect for the bones of "*Tetrabelodon*." His success led the writer, accompanied by Mr. Harold Eaton, to join him at once. The party camped for ten days in Devil's Gulch and obtained two wagon loads of excellent material. Exploratory work was then continued by Mr. Whitford until October.

The Niobrara River, which is the boundary between Brown and Keya Paha counties, has a broad valley, perhaps a mile across at this point. The land immediately adjacent is considerably cut by side streams, some of which show bold bluffs and canyon walls. Dutch Creek flows for several miles between deep, precipitous walls, and empties to the north into the Niobrara. Extending in a northwesterly direction, as a tributary to Dutch Creek, is Devil's Gulch, a narrow, precipitous, picturesque canyon, about 225 feet deep, and scarcely more than a mile in length. Certain portions of the canyon are heavily forested with bull pine, yet the walls are mostly bare and precipitous for they are subjected to the heavy erosive action of wind and rain, and many well-preserved bones are exposed. This Gulch is about 15 miles north of Ainsworth, upon the three-thousand-acre ranch of Mr. William A. Jamison, through whose courtesy the University was allowed to collect at will.

A geologic section of the place is readily obtained by following the course of the canyon. At the junction of the Gulch with

PLATE V.

Tetrabelodon willistoni. Side view showing flat occiput, narrow, but well-arched dome, and long jaw with tusks. The tool marks indicate the parts restored. The upper molars are Nos. 1, 2, 3, and 4. The lower molars are Nos. 2, 3, and 4. Attention is directed to the lachrymal bone.

PLATE VI.

a

b

Tetrabelodon willistoni. *a*, top view of skull showing a narrow, but well-arched dome, flattish occiput, expanded anterior nares, and greatly reduced nasals. Tool marks indicate restored parts. *b*, palatine view, showing bifurcated maxillae, narrow posterior nares, and teeth, Nos. 1, 2, 3, and 4. Tool marks at base of skull indicate restoration.

Dutch Creek, large banks of Pierre shale are exposed. The very topmost layer, some 50 feet in thickness, is a bright ochre-yellow color, instead of the customary dull, slate color. There are certain thin, flinty, nodular bands, traces of which are found as far as Sioux County. This bed has been traced to the west and to the north, well into South Dakota, especially around the Rosebud Agency. To the southwest, in Furnas County, near Beaver City, the ochreous, flinty, nodular layers are very pronounced. The character of this 50-foot bed seems constant, and we made free in our field notes to call it the Ainsworth formation. Above the Pierre occurs the well known Oligocene bad lands, which in certain exposures shows a thickness of about 100 feet. Immediately overlying this come 225 feet of sandy beds belonging to the "Loup Fork." In our field notes, we have called this the Devil's Gulch stage.

As to the geological horizon, the faunal evidence suggests Pliocene equivalent to the Snake Creek beds of southern Sioux County. Possibly some Pleistocene may be represented. Further study will be necessary to determine accurately the geologic position of this newly explored fossil field. Faunal comparisons show this bed to be much earlier than that of Hay Springs, and later than that of the famous Agate Springs Quarries. It will not be far wrong to call the Devil's Gulch deposits, Pliocene. The upper part may merge into Pleistocene. Unlike the beds at Agate Springs, which are sufficiently lithified to make the chisel and pick necessary, the beds at Devil's Gulch are so loose and sandy, that work is greatly facilitated. Only occasionally are mineralized or concretionary patches encountered.

The bones, when freshly exhumed, are of a light brown color, changing to whitish on continued exposure to sunlight. The bones near the base of the canyon seem to be harder and more enduring than those near the top which are soft and perishable to the last degree, demanding skillful treatment.

TWO NEW MASTODONS FROM DEVIL'S GULCH

The discovery of two new mastodon skulls, with mandibles, and certain skeletal parts, is of special interest, and constitutes the

main feature of this collection, and of this preliminary report. These skulls were found on levels separated by 75 feet of sediment, apparently aqueous in origin. Just half way down the canyon, at a point named Quarry No. 2, were found the skull, mandible, ribs, tusk, and a cervical vertebra of a species of young "*Tetrabelodon*," somewhat similar to *Trilophodon productus.* Seventy-five feet higher than this at Quarry No. 1, near the rim of the canyon, was found a much larger, different mastodon, with skull, tusks, mandible, ribs, and pelvis. We have named these, respectively, Tetrabelodon willistoni, and Eubelodon morrilli.

TETRABELODON WILLISTONI, sp. nov.

This species, consisting of a nearly perfect skull with mandible, one cervical vertebra and numerous ribs, was found in Quarry No. 2, about 115 feet below the general level, 75 feet below, and about 300 feet distant from Quarry No. 1. This species is named for Dr. S. W. Williston. The skull lacks parts of the zygoma, one exoccipital, part of the other, and the basioccipital. The mandible is without blemish. The skull is narrow, and with inferior dome. The occiput, though slightly convex, is noticeably flat, and is furrowed but little along the median line. There is a well-marked, though broad, occipital crest. This is very unlike the occiput in *Elephas,* which is noticeably convex. The exoccipitals and parietals of *Elephas* round gently and without crest. The pit is so deep that it extends well to the inner cranial wall. The posterior nares are very narrow, and long postero-anteriorly. The anterior nares are widely expanded with thick borders. The basicranial bones are deflected only about 10 degrees from the palatine plane.

During the growth of a proboscidean, the size of the brain from youth to maturity does not change much. Furthermore, in the case of the young of *Elephas,* the proportion of the cranium to the brain is quite normal. But in the case of adults, the skulls are abnormally inflated by air cells, and this greatly emphasizes the disparity between the relatively small brain cavity and the immense skull. Though not an adult, the air cells in the skull of *Tetrabelodon willistoni* are small, and the inflation moderate. It

PLATE VII.

Skull of Modern Elephant. Top and side views of *Elephas indicus*. For comparison with *Tetrabelodon willistoni*. From a specimen in the State Museum.

seems intermediate between the more typical ancestral forms and the later extreme forms.

In all, some 5 or 6 tusks of this species were found. They average about 3 feet (915 mm.) in length, and about 3 inches (77 mm.) in greatest diameter. The upper tusks curve downward and diverge at the tips, and on the outer side is a relatively broad, flat, enamel band, resting upon the dentine and presenting distinct edges. Each and every tusk from this level shows a similar enamel band. In the case of one or two tusks, the band has become almost vestigial, and represents an interesting transitory stage. In one example, the enamel band is about an inch broad near the tips. It rests upon, and well above, the dentine, and presents distinct edges. It narrows posteriorly to a fourth of an inch, and its edges become imbedded in the dentine of the tusk. Near the alveolus, it sinks somewhat into the dentine.

The teeth are trilophodont. Those of the upper jaw are four in number, of the lower, three. All of the "*Tetrabelodon*" teeth found on this level seem to be small. In the upper molars, the outer tubercles are long and conical, with light cingulum, and with no secondary cones to fill the valleys. On the inner side, however, the tubercles are crowded with secondary cones, the valleys obstructed, and the cingulum strong and serrated by conelets.

The mandible is in a state of perfect preservation. Its length is 30 inches (762 mm.) and the extreme width across the condyles is 14½ inches (368 mm.). It is but slightly decurved, and has a deep lingual groove with sharp edges. The mandibular border rounds into the ascending ramus without angle. The ascending ramus is strong and relatively high. The condyle has a distinct neck, and stands 4 inches (102 mm.) above the grinding surface of the molars. The sigmoid notch is deep, and the coronoid high and prominent. It resembles the typical coronoid more closely than does any proboscidean with which the writer is familiar. The symphysial prolongation is 9 inches (230 mm.). Two strong mandibular tusks project 4 inches (102 mm.) from the jaw, and are 1⅝ inches (42 mm.) through. They are worn obliquely at the tips, as shown in the accompanying cuts. The

upper tusks had dropped out, but the tip of one, found in close proximity, undoubtedly belongs to this skull. Numerous other tusks were found on this level, and all show pronounced enamel bands. This early proboscidean is neither as low-browed, nor as long-jawed as one might expect.

The widely expanded anterior nares, the retreating and thickened nasals, and the breadth of surfaces for attachment of muscles, suggests the probability of a fairly well-developed, though not large, proboscis. But the tusks were light, and the combined load imposed upon the neck muscles did not demand great expanse of skull surface.

EUBELODON MORRILLI, gen. et sp. nov.*

Quarry No. 1 is 75 feet higher up the canyon wall, and about 35 feet below the general level of the surface, perhaps 100 yards to the southeast of Quarry No. 2. From this point, another proboscidean skull and mandible, complete pelvis, ribs, and stray limb bones were secured. We have named this specimen *Eubelodon morrilli,* in honor of Honorable Charles H. Morrill, a former President of the Board of Regents, and for many years a patron of the Department. This individual is larger in size than the first mentioned, and has marked structural differences. The mandible is destitute of tusks. In some respects, *Eubelodon* seems to be a more primitive form than *Tetrabelodon willistoni.* It is a large, exceptionally long-jawed, low-browed proboscidean. The mandible is fully 43 inches (1,902 mm.) long, and 20 inches (509 mm.) across the condyles, and has but one large tooth in each ramus. The symphysial prolongation is 15½ inches (393 mm.). The lingual groove is shallow, with rounded edges. The skull, as far as it has been worked out is rather flat and long.

The two tusks, found in exact position, are finely preserved. They curve downward, slightly outward, and are without enamel bands. The tusks are worn to sharp, chisel-like tips. A section of the tusk near the alveolus is an inverted ovoid 4½ inches (115 mm.) in vertical diameter, and 3½ inches (89 mm.) in horizontal diameter, with a pulp cavity 2¾ (70 mm.) × 1¾ inches (45 mm.).

* The proposed generic name, Eubelodon, signifying well-tusked, euphonically implies relationship to Tetrabelodon and Dibelodon.

LATE VIII.

Tetrabelodon willistoni. *a*, mandible showing slightly decurved symphysis; deep groove, and two strong tusks; molars 2, 3, 4; strong ascending rami; relatively high condyles and coronoids, and a pronounced sigmoid notch. *b*, top view. *c*, bottom view.

PLATE IX.

Eubelodon morrilli. Palatine view of skull showing wedge-shaped tusks, molar No. 6, and large circular, posterior nares. The tinted area at the base of the skull signifies restoration. Photographed under nearly impossible conditions.

The mandible of *Eubelodon morrilli* constitutes a striking character. It is massive, straight, and of great length, with low ascending rami. In life the tusks projected scarcely more than a foot and a half beyond the jaw and lip. There are no inferior tusks. The symphysial prolongation is 15½ inches 393 mm.) and is not decurved. The mandible is massive up to the symphysis, where it begins to contract somewhat, then tapers rapidly to the tip. Two grooves, one to the right, and one to the left, parallel the lingual groove, noticeably reducing the bulk of the symphysial portion. Perhaps this is but prophetic that the symphysial portion is destined to become vestigial as in *Elephas.*

In *Eubelodon morrilli,* the end of the long, straight, massive tapering mandible comes well towards the tip of the tusks, thus making an interesting, if not grotesque, facial portion to the skull. It is an unmastodon-like mastodon. The teeth are reduced to one in each jaw, and they measure about 3½ inches (89 mm.) by 8 inches (203 mm.). These teeth have four deeply worn ridges, showing inner and outer trefoiled cones, and a small fifth ridge or heel. Alveolar impressions in the maxillae show where a preceding tooth has been crowded out by a horizontal successor. The ascending rami are low, being at most but 3 inches (77 mm.) above the grinding surface of the molars. They are capped by nearly circular condyles of low convexity, and unlike *Elephas* are without necks. Contrast with this *Elephas imperator,* in which the ascending rami are about 11 inches (280 mm.) above the grinding surface, and that of *Elephas indicus,* which are about 9 inches (230 mm.).

The coronoids are on a level with the condyles, and, though somewhat compressed, are thick and strong compared with any fossil or living elephant. The sigmoid notch is very shallow. The inferior mandibular border, which is very broad and round at the molars, narrows and swings by an easy curve into the ascending ramus.

The tusks of *Eubelodon morrilli* are relatively large, but short, distinctly wedge-shaped at the tips, and without enamel bands. Starting at the skull, where the maxillae are just 1 foot (305 mm.) across from outside to outside, the tusks diverge until they are 3

feet (915 mm.) apart at the tips, and curve downward slightly. Each tusk is 4 feet (1,220 mm.) long. One foot of the tusk is firmly imbedded in the jaw, and an additional 6 inches is partly sheathed and buttressed by the maxillae. Since the tusks are sheathed by the maxillae in the typical Proboscidea, they have been considered by some as morphologically canine teeth. The skulls of young elephants show that the tusks are erupted from the premaxillae and are incisors.

Incident to growth from persistent pulps, the young incisors naturally outgrow the limits of the premaxillae, and invade the maxillae. They are incisors grown indefinitely large. In most Tetrabelodons, there is a conspicuous bifurcation of the maxillary sheath, but especially so in *Eubelodon morrilli.* Beyond the tips of the maxillae, the tusks project 30½ inches (776 mm.).

The skull is still in the hands of preparators, and has not yet been fully worked out or turned over, to show the anterior narial apertures. From observation in the quarry, it seems that the surface for the attachment of the muscles of the proboscis is restricted in area. Undoubtedly the proboscis, that most distinctive badge of the group, was only partly developed, and was short.

The posterior narial aperture is large, nearly circular, and with vertical walls. Its antero-posterior diameter is 4½ inches (115 mm.). The transverse diameter is 3½ inches (90 mm.). From its anterior border to the tips of the maxillae is 24 inches (610 mm.). The basicranial elements, and the palate lie in a plane perforated by the postnarial aperture, while in *Elephas* these same parts are at right angles.

That the cancellous portions of the bone of the brain box lack the extreme inflation of air cells common in *Elephas* is quite apparent, and is readily accounted for. Though the head was very large, larger than an ordinary elephant, the tusks and trunk were not ponderous, and did not demand such an abnormal surface area for the attachment of muscles.

The pelvis, including sacrum and sacral spine, is perfectly preserved, and indicates an animal of large size. The acetabulum measures 6½ inches (165 mm.) in diameter. The neural arch measures 1½ inches (38 mm.) The pelvic aperture is 16 inches

PLATE X.

Eubelodon morrilli. *a*, mandible, side view, showing low, ascending rami, low condyles and coronoids. Length 43 inches (1,092 mm.). *b*, top view. Sixth molar 8 × 3½ inches (203 × 89 mm.). Symphysial prolongation 15½ inches (393 mm.). *c*, bottom view.

(407 mm.) transversely, by 14 inches (356 mm.) vertically. The thyroid foramen is $7\frac{1}{2} \times 4\frac{1}{2}$ inches (192×115 mm.). The extreme width across the ilia is 56 inches (1424 mm.).

HYPOHIPPUS MATTHEWI sp. nov.

Two maxillae of a very large *Hypohippus,* together with scattered lower teeth, and numerous skeletal parts, were found below but near Quarry No. 1, Devil's Gulch. Some of these bones occurred in a bed of white diatomite, about 10 inches thick, and about 150 feet long. Several complete feet, and numerous limb bones were dug out of this diatomite, and were so faultlessly preserved that it may be said, a better matrix cannot be found. The feet found in the diatomite confirm the belief that this genus is tridactyl. *Hypohippus* is a horse of forest adaptation. Several species are known, notably *Hypohippus affinus, H. osborni,* and *H. equinus. Hypohippus matthewi* exceeds all of these in size. It is undoubtedly the largest member of the genus known as yet.

Hypohippus matthewi, named for Dr. W. D. Matthew, though closely resembling *Hypohippus affinis* is much more hypsodont, and is from one-fifth to one-eighth larger, as may be seen in the accompanying half tone figures, which are exact size. It is presumably a later mutant.

Hypohippus is closely related to *Anchitherium,* and is classed as the most advanced member of the *Anchitheres.* The briefest description of the teeth of *Hypohippus matthewi* is that they are *Mesohippus* enormously enlarged. They are strikingly similar point for point. It should be noted that *Anchitherium,* the European form, is closely related to *Mesohippus,* the American.

Though represented at one time by roving herds of many varieties, horses are now reduced to but one family, the Equidae, which includes the three living genera, *Assinus* (the wild asses), *Hippotigris* (the zebras), and *Equus* (the true horses).

Our modern horses, though monodactyl in one sense, are tridactyl in another, for the two splint bones are ancestral toes persisting at the present time.

Ancestral horses are characterized by long bodies, arched backs, short limbs, short necks, short teeth, long tails, and polydactyl

feet. The opposite is true of the later equines. The ancestral horses fall into four groups, each including its quota of genera. The fossil horses are assembled under the divisions: (1) Hyracotheres; (2) Anchitheres (3) Protohippines; and (4) Equines, the later horses.

Ancestral horses had cementless, short-crowned, brachydont teeth, while later members of the branch had partly cemented crowns of considerable length, sub-hypsodont; and the more recent members had very long, cemented crowns, hypsodont teeth.

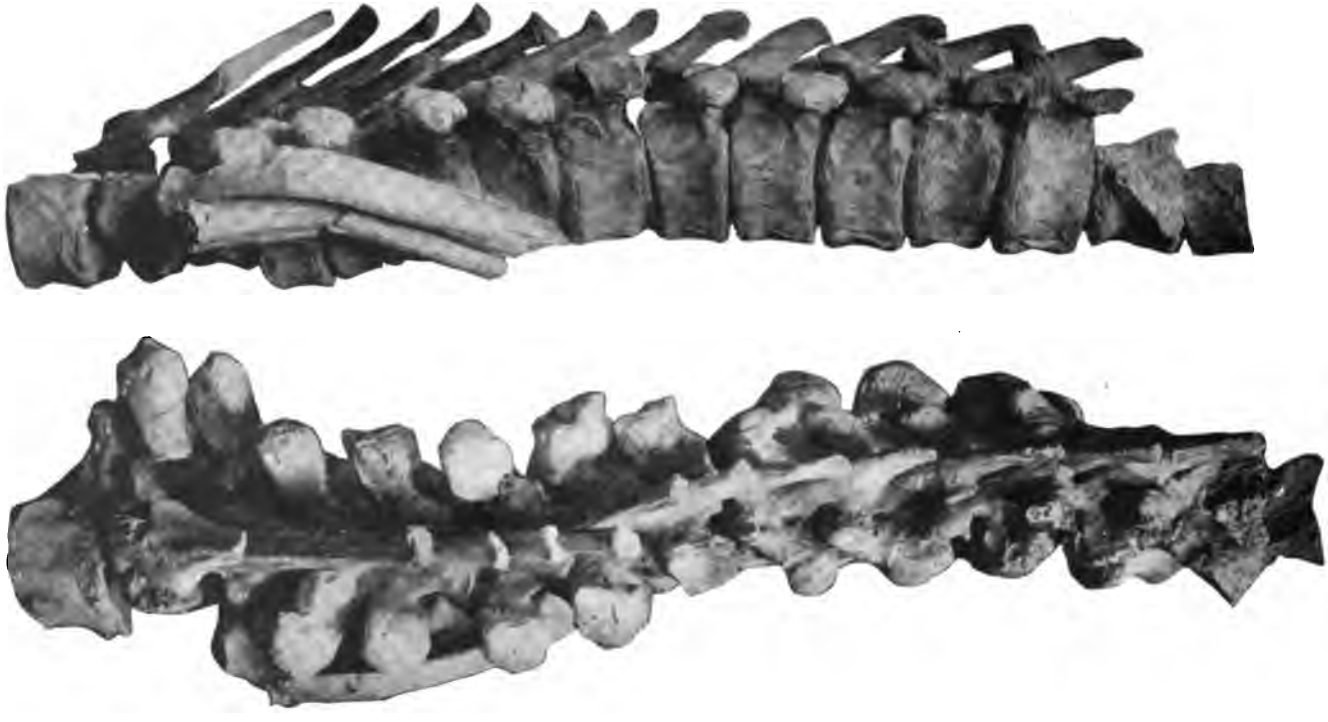
It is an interesting fact that in the same bed with *Hypohippus matthewi,* simple and complex, short-crowned, and long-crowned teeth were found intermingled. This emphasizes the fact that the old and less advanced forms of equids persisted and mingled with the new and more advanced types.

In *Anchitherium, Mesohippus, Hypohippus,* and closely related forms, the transverse crests of the teeth are generally distinct and perfect. In *Hypohippus matthewi,* the metaloph is continuous with the ectoloph. This cross crest runs obliquely forward, then obliquely backward and meets the ectoloph at the mesostyle. The styles are well developed, and the parastyle is bold and strong. The fosettes are very deep, and the bounding walls nearly vertical. The protoloph runs obliquely forward and outward by a sigmoid curve to the anterior border of the tooth. It is entirely disconnected from the ectoloph in the premolars, but gradually becomes more connected in the first molar. The teeth are fully adult, though not old, with the outer crest and cross crests worn. The teeth, especially those of the left side, show pronounced cement reinforcement half way up the crown, and all are etched by "Daimonelix fibers."

Measurements of the teeth of Hypophippus Matthewi:

Pm 1. Missing. Represented by an alveolar scar and root.
Pm 2. Antero-posterior diameter along outer border, 38 mm.
Diameter through hypoconule to front of tooth, 31 mm.
Greatest transverse diameter, 36 mm.
Extreme height of crown, 30 mm.
Pm 3. Antero-posterior diameter along outer border, 37 mm.
Diameter through hypoconule to front of tooth, 32 mm.
Greatest transverse diameter, 41 mm.

PLATE XI.



Vertebrae, *Eubelodon morrilli*. *a*, side view of fifteen vertebrae. Eleven were found in position with ribs attached. All ribs save two have been removed. *b*, dorsal view. × 1/8.

PLATE XII.

Eubelodon morrilli. Pelvis with sacrum. Practically without blemish. Extreme width 56 inches (1,424 mm.); pelvic aperture 16 inches (407 mm.); thyroid foramen 4½ × 7½ inches (115 × 192 mm.).

Extreme height of crown, 36 mm.

Pm 4. Antero-posterior diameter along outer border, 35 mm.
Diameter through hypoconule to front of tooth, 33 mm.
Greatest transverse diameter, 43 mm.
Extreme height of crown, 36 mm.

M 1. Antero-posterior diameter along outer border, 36 mm.
Diameter through hypoconule to front of tooth, 33 mm.
Greatest transverse diameter, 41 mm.
Extreme height of crown, 29 mm.

Hypophippus affinis, Leidy:

2d or 3d upper molar. Antero-posterior diameter along outer border, 29 mm.
Diameter through hypoconule to front of tooth, 26 mm.
Greatest transverse diameter, 27 mm.
Extreme height of crown, 15 mm.

Partial Faunal List, Devil's Gulch Beds

Turtle

1. *Testudo orthopygia*
2. *Testudo,* undetermined.

Canids

3. *Aelurodon*
4. *Tephrocyon*
5. *Cynarctus,* sp. nov.
6. *Cyon*
7. *Temnocyon*?

Mustelids

8. *Mustelid,* undetermined

Felids

9. *Machaerodus,* sp. nov.

Camels

10. *Oxydactylus*
11. *Alticamelus*
12. *Procamelus*
13. *Pliauchenia*
14. Camel, undetermined

Oreodonts

15. *Metoreodon*

Merycodonts

16. *Merycodus necatus*

Rhinoceros

17. *Teleoceras*
18. *Rhinoceros,* undetermined

Equids

19. *Parahippus*
20. *Hypohippus*
21. *Merychippus*
22. *Protohippus*
23. *Pliohippus*
24. *Hipparion*

Proboscideans

25. *Tetrabelodon willistoni,* sp. nov.
26. *Mastodon euhypodon?*
27. *Mastodon,* undetermined
28. *Mastodon morrilli,* sp. nov.

THE UNIVERSITY OF NEBRASKA,
December, 1913

PLATE IV

Evolution of the Proboscidea. Freehand sketches, approximately to scale, from casts and specimens in the collection of Honorable Charles H. Morrill, State Museum. 1, *Moeritherium.* Ancestral proboscidean, Upper Eocene, Egypt. 2, *Palaeomastodon.* Lower Oligocene, Egypt. 3, *Tetrabelodon.* An early four-tusked mastodon. Miocene. 4, *Tetrabelodon willistoni.* A late four-tusker. A trilophodont mastodon. Pliocene of Nebraska. 5, *Eubelodon morrilli.* A trilophodont mastodon, Pliocene. Devil's Gulch, Nebraska. 6, Mastodon. *Mastodon americanus.* Common in Nebraska. Pleistocene. 7, Mammoth. *Elephas primigenius.* Pleistocene. Three species, the Columbian, Imperial and Primitive, are abundant in Nebraska. Pleistocene.

PLATE I

General View of Devil's Gulch. Looking up the canyon. Quarry No. 1 is at *a.*

PLATE II

Nearing the Brink of the Canyon. Dragging out, by means of block and tackle, a slab containing the skull of *Tetrabelodon willistoni.* Quarry No. 2 is at *a.*

PLATE XIII.

Stray Mastodon Bones from Devil's Gulch.

Eubelodon morrilli, *a*, *b*, *c*, *d* and *e*.

a, left femur from above. × 1/8.

b, same, back view. × 1/8. Across head and tuberosity 14 inches (355 mm.).

c, patella.

d, right tibia and fibula united. Apparently not pathological. × 1/10. Tibia 22 inches (560 mm.) long.

e, left humerus, front view. × 1/8.

Tetrabelodon willistoni, *f*, *g* and *h*.

f and *g*, front and back view of left humerus. × 1/10. Total length 25 inches (635 mm.).

h, five tusks showing varying widths of enamel bands.

PLATE III

Scene at Devil's Gulch. Dragging the pelvis of *Eubelodon morrilli* over the brink of the canyon by means of block and tackle.

PLATE V

Tetrabelodon willistoni. Side view showing flat occiput, narrow, but well-arched dome, and long jaw with tusks. The tool marks indicate the parts restored. The upper molars are Nos. 1, 2, 3, and 4. The lower molars are Nos. 2, 3, and 4. Attention is directed to the lachrymal bone.

PLATE VI

Tetrabelodon willistoni. a, top view of skull showing a narrow, but well-arched dome, flattish occiput, expanded anterior nares, and greatly reduced nasals. Tool marks indicate restored parts. *b,* palatine view, showing bifurcated maxillae, narrow posterior nares, and teeth, Nos. 1, 2, 3, and 4. Tool marks at the base of skull indicate restoration.

PLATE VII

Skull of Modern Elephant. Top and side views of *Elephas indicus.* For comparison with *Tetrabelodon willistoni.* From a specimen in the State Museum.

PLATE VIII

Tetrabelodon willistoni. a, mandible showing slightly decurved symphysis; deep groove, and two strong tusks; molars 2, 3, 4; strong ascending rami; relatively high condyles and coronoids, and a pronounced sigmoid notch. *b,* top view. *c,* bottom view.

PLATE IX

Eubelodon morrilli. Palatine view of skull showing wedge-shaped tusks, molar No. 6, and large circular, posterior nares. The tinted area at the base of the skull signifies restoration. Photographed under nearly impossible conditions.

PLATE X

Eubelodon morrilli. a, mandible, side view, showing low, ascending rami, low condyles and coronoids. Length 43 inches (1,092 mm.). *b,* top view. Sixth molar $8 \times 3\frac{1}{2}$ inches (203×89 mm.). Symphysial prolongation $15\frac{1}{2}$ inches (393 mm.). *c,* bottom view.

PLATE XI

Vertebrae, *Eubelodon morrilli. a,* side view of fifteen vertebrae. Eleven were found in position with ribs attached. All ribs save two have been removed. *b,* dorsal view. $\times \frac{1}{8}$.

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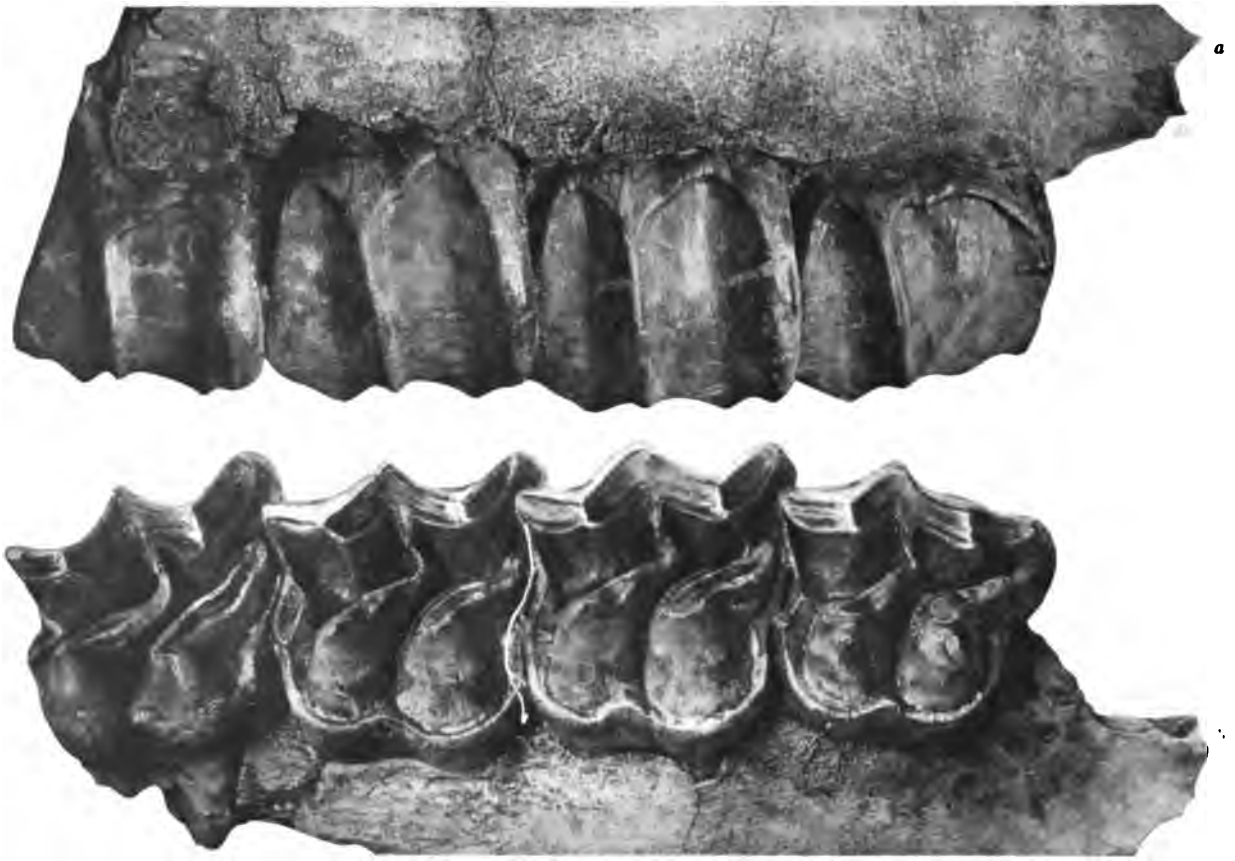
f and *g,* front and back views of left humerus. × 1/10. Total length 25 inches (635 mm.).

h, five tusks showing varying widths of enamel bands.

PLATE XIV

Hippohippus matthewi. a, side view showing unusually hypsodont teeth. *b,* top view. These teeth are reproduced to exact size for the sake of measurement and comparison.

PLATE XIV.



Hippohippus matthewi. *a*, side view showing unusually hypsodont teeth. *b*, top view. These teeth are reproduced to exact size for the sake of measurement and comparison.